APPENDIX J

No Net Increase Load Proposal for Total Phosphorus

No Net Increase Total Phosphorus Loads for the Lower Boise River Watershed

A Discussion of Issues and Proposed Loads for Sources

Introduction

A review of Boise River water quality conditions shows that the river is highly enriched with phosphorus. Between Middleton and Caldwell, attached algae growth significantly exceeds quantities observed at the upper end of the watershed, and exceeds suggested nuisance thresholds for other rivers. The Boise River nutrient data and productivity in the lower Snake River indicate the need to cap phosphorus loading to the Boise River until basin wide phosphorus limits protective of water quality are established. The no net increase proposal for total phosphorus described in this paper provides the temporary cap that is needed.

The proposed no net increase TMDL for phosphorus for the lower Boise River watershed would establish seasonal load limits for total phosphorus for point sources, non point sources, the Boise River near Middleton, and the river near Parma. The river sites will serve as benchmarks to ensure that the no net increase requirements are met. DEQ expects that the no net increase goal can be achieved using methods including (but not limited to) pollutant trading, best management practices, and nutrient removal technologies.

The no net increase TMDL for total phosphorus in the lower Boise River watershed is likely to be temporary. The proposals outlined below are expected to apply for two years, from the effective date of the lower Boise River TMDL until the effective date of the Brownlee Reservoir TMDL. The expected date of completion for the Brownlee TMDL is the year 2000. The Brownlee Reservoir TMDL may require reductions based on either concentrations or loads of phosphorus species (total and/or dissolved) from the Boise River.

Baseline Year Selection

The proposed no net increase TMDL for the lower Boise River watershed uses the 1996 calendar year as the baseline time period for sources of phosphorus and the river itself. The year selected is consistent with the Watershed Advisory Group's recommendation to use 1996 as the date after which water quality controls could be credited toward TMDL requirements.

Pollutant of Concern

Total phosphorus is the species proposed for the no net increase TMDL in the lower Boise River watershed. Literature describing studies of attached algae growth indicates that total, rather than dissolved ortho-phosphorus, has the best correlation with periphyton productivity. Analysis of periphytic algae growth in the Clark Fork River produced the same conclusion about total phosphorus.

Time Period for No Net Increase

DEQ calculated the proposed no net increase loads shown below based the standard irrigation season, from April 15 to October 15. A date between March 1 and April 15 is another possible choice for the start of a seasonal time period, recognizing that algae growth may begin before irrigation activity. Other time periods, such as the typical high flow season, from

February 15 to June 14, or a calendar year can also be considered. DEQ welcomes any comments or suggestions related to the most appropriate time period.

Proposed Loads - Seasonal Average with Mass Total

The seasonal average and mass total concept for no net increase loads provides a way to limit the mass of phosphorus moving through the river and ensure that load inputs are evenly distributed by the seasonal average limit. A seasonal average has the added benefit of reducing monitoring demands in comparison to an average applied over a shorter time frame. DEQ is open to discussion of other strategies, such as multiple monthly averages, or annual averaging. The methods used to establish the loads shown in Table 1 are described below.

Boise River near Middleton	888 lbs/day	163,415 lbs mass total
Boise River near Parma	2295 lbs/day	422,369 lbs mass total

Table 1. Proposed No Net Increase Total Phosphorus Loads by Source

Facility Name	Seasonal Average TP Load, lbs/day	Seasonal Total Load lbs	Tributary Name	Seasonal Average TP Load, lbs/day	Seasonal Total Load lbs
Lander St	440	80939	Eagle Drain	30	5566
West Boise	778	143088	Thurman Drain	19	3563
Meridian	68	12579	Fifteenmile Creek	241	44411
Nampa	498	90713	Mill Slough	197	36277
Caldwell	230	42300	Willow Creek	30	5438
			Mason Slough	59	10863
Minor Muni.	14	2373	Mason Creek	340	62539
			East Hartley Gulch	96	17707
			West Hartley Gulch	40	7302
			Indian Creek	164	30219
			Conway Gulch	101	18648
			Dixie Drain	444	81672

Characteristics of 1996 Flows

The Boise River carried a larger than average annual total volume of water during 1996. However, during the irrigation season, 1996 flows, while above average, were only modestly larger than irrigation season flows in 1995. Thus the 1996 flows for the season during which the no net increase proposal would have effect are not extreme. The table below compares 1996 loads to 1995 and to 1992 (the lowest flow year on record since 1955). The lowest year on record, 1992, clearly has much smaller loads, as would be expected for an extreme event. The annual load of total phosphorus in 1996 is larger than annual total loads in 1995 or 1992. However, for the irrigation season, the 1996 loads at Middleton and Parma are not very different from 1995 loads. The selection of the 1996 irrigation season as a baseline seems like a sound choice for the purpose.

1996 Loads Compared to Average and Low Flow Years

Table 2. Load Comparison

Site	1996 Proposed Load	1995 Average Load	1992 Average Load
Boise River near Middleton	888 lbs/day	817 lbs/day (1996 is 9% larger)	222 lbs/day (1996 is 300% larger)
Boise River near Parma	2295 lbs/day	2346 lbs/day (1996 is 2% *smaller*)	513 lbs/day (1996 is 350% larger)

Tributary Flows in 1996 Relative to Other Years

Tributary flows during the irrigation season of 1996 are close to long term averages, and are similar to 1995 flows. In fact, although 1995 was an average flow year for the Boise River, during the 1995 irrigation season flows in tributaries are similar or slightly higher on average than in 1996. Irrigation season average flows in Table 3 show that 1996 is not an extreme year for some of the large tributaries to the lower Boise River. Figure 1, (attached to this document), shows Mason Creek flows in 1992, 1995, and 1996, providing an example of the fact that 1996 was not an extreme year for Mason Creek.

Table 3. Irrigation Season Average Flows in Tributaries, cfs

Year	Fifteenmile Creek	Mason Creek	Dixie Drain
Long term Average	118	130	206
1992	51	91	154
1995	163	164	248
1996	143	152	212

Methodology

The general methodology for establishing baseline loads includes these steps:

1. Create best fit model to predict total phosphorus concentration, using FLUX software or non-linear model. Use seasonal or flow stratification, if necessary, to minimize error.
2. Use daily 1996 flow data and the model from step 1 to predict daily total phosphorus concentrations
3. Calculate daily total phosphorus loads for the entire 1996 calendar year.
4. Summarize the daily loads seasonally, annually, by averages, and by mass totals.

The FLUX model is an Army Corps of Engineers program that uses three averaging and three linear regression techniques to predict nutrient loads based upon sample data and daily flow information. The model provides goodness of fit and error analysis information for each method of estimating load. Data can be quickly stratified into groups by flows or by dates to improve the predictive power of the six modeling techniques. For every source to which the FLUX model was applied, DEQ selected one method (of the six available) that provided the best fit to measured data, minimum coefficient of variation, and minimum variance. The best method was then used to calculate daily loads for the entire 1996 calendar year. Specific details of the method selected for a given source are available upon request, but are too numerous to list here.

River Sites

To define the total phosphorus loads that occurred in the Boise River at Middleton and Parma during 1996, all of the available data from the USGS form the basis of models that predict total phosphorus concentration. Daily flow records from USGS gage site at each site are applied to the models to predict the daily total phosphorus concentrations for 1996. Daily loads are calculated using the daily flows and predicted concentrations. Summary statistics of the type shown above are based upon the predicted daily loads for 1996.

Middleton

At Middleton, the US Army Corps of Engineers FLUX model provided the best fit model for total phosphorus, given a stratification of the data by the irrigation and non-irrigation seasons. A linear regression on natural log adjusted data points provided a good fit with a 0.080 coefficient of variation and an error of +- 82 pounds for the annual total load.

Parma

For the Parma river site, USGS data showed a distinct non-linear relation between flow and concentration that cannot be made linear with natural log adjustment of the data. To predict total phosphorus concentrations based upon flow, two no linear models are fit based on a date stratification of the available measured data. The models are as follows:

Total Phosphorus Predictive Equations

Dates: February 15 to October 15
[TP] = 0.032 + 0.38*exp(-0.00045*Flow^0.95)

Dates: October 16 to February 14
[TP] = 0.18 + 0.68*exp(-0.00045*Flow^1.12)

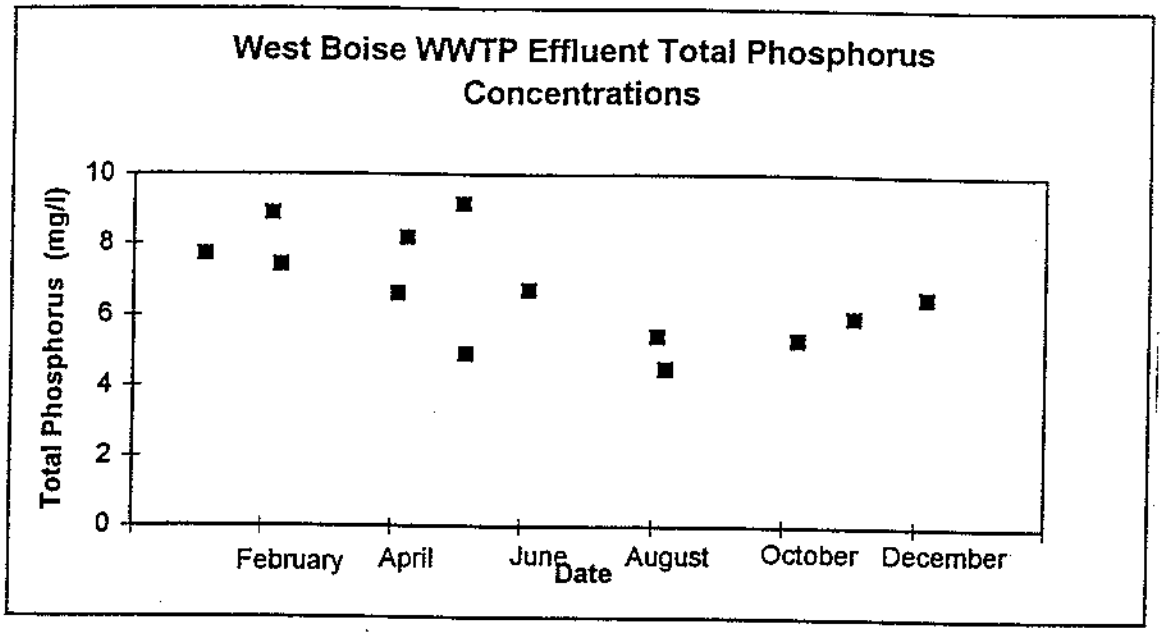
The models shown predict total phosphorus in the Boise River at Parma quite well, with about 7% under-prediction on average. A detailed report on the development of the Parma models, titled "Summary of 1996 Total Phosphorus Loads at Parma", is available upon request.

Waste Water Treatment Plants

In order to appropriately characterize waste water treatment facility effluent characteristics, DEQ used the FLUX program to create models that predict total phosphorus concentrations. From the daily total phosphorus concentration estimates generated by the model, daily loads are calculated using effluent flow data supplied by the facilities. Since operations and inputs to the treatment plants change for year to year, only flow and total phosphorus measurements from 1996 form the basis of the modeling. The Lander Street, West Boise, Meridian, Nampa, Caldwell, and Middleton phosphorus estimates are all based upon FLUX.

West Boise provides a good case example of FLUX modeling for a waste water treatment plant. For 1996, 13 total phosphorus measurements are available to characterize the effluent for the year. An initial estimation of loads without any adjustment shows that coefficients of variation are 0.060 or greater for the six methods. Figure 2, a graph of concentrations versus month, suggests that breaking the data into two groups would improve the fit of the model.

Figure 2. West Boise 1996 Effluent Total Phosphorus Concentrations



A stratification of the West Boise into two groups, split by August 1, 1996, yields a much better fit for the six FLUX methods of load estimation. After the stratification, Method 2, the flow weighted average, has an improved coefficient of variation of 0.048, and an error of +- 38 pounds for the annual load.

The smaller facilities did not have sufficient data available to run the FLUX software. For Star and Wilder, a single average total phosphorus concentration is applied to monthly average data to approximate the load from the two facilities. There are no phosphorus measurements available for Wilder during the 1990s, but the facility has a design similar to that of the Star WWTP. Thus, the average total phosphorus concentration from the Star plant was applied to the Wilder average flow data to roughly estimate the load from the facility. The Notus WWTP did not discharge during the standard irrigation season. The Notus facility typically discharges only twice per year for periods of time less than two weeks. The quantity of phosphorus generated by Notus in 1996 is estimated to be about 23 pounds, all discharged during the non-irrigation season.

Tributaries

The total phosphorus load for any tributary is based upon FLUX model results similar to those for treatment plants. In the case of tributaries, the complete USGS monitoring data provides the basis for creating a predictive model for total phosphorus concentration. Since tributaries do not have the kind of rapid operational and input changes that occur in treatment plants, the full record of data best characterizes the phosphorus loads from drains. The tributary modeling proceeded according to the same methods described for the treatment plants, using date and flow stratification as needed to provide the best fit to the measured data. Specific details of the method used for each tributary and associated coefficients of variation are available upon request, but are too numerous to list here.

Questions for Your Consideration

- Is 1996 an appropriate baseline year?
- Is a seasonal versus and annual approach the best choice for establishing total phosphorus no net increase loads?
- If a seasonal approach is selected, what is the appropriate date for the beginning of the season?
- What are appropriate strategies for assessing compliance with no net increase requirements?

References

Dodds, Walter K., and Val H. Smith, Managing Excess Chlorophyll Levels in the Clark Fork River with Nutrient Controls, Report for the Montana Department of Health and Environmental Sciences, April, 1995, p. 5.

Walker, William, Simplified Procedures for Eutrophication Assessment and Prediction: User Manual, U.S. Army Corps of Engineers Waterways Experiment Station, W-96-2, September, 1996.

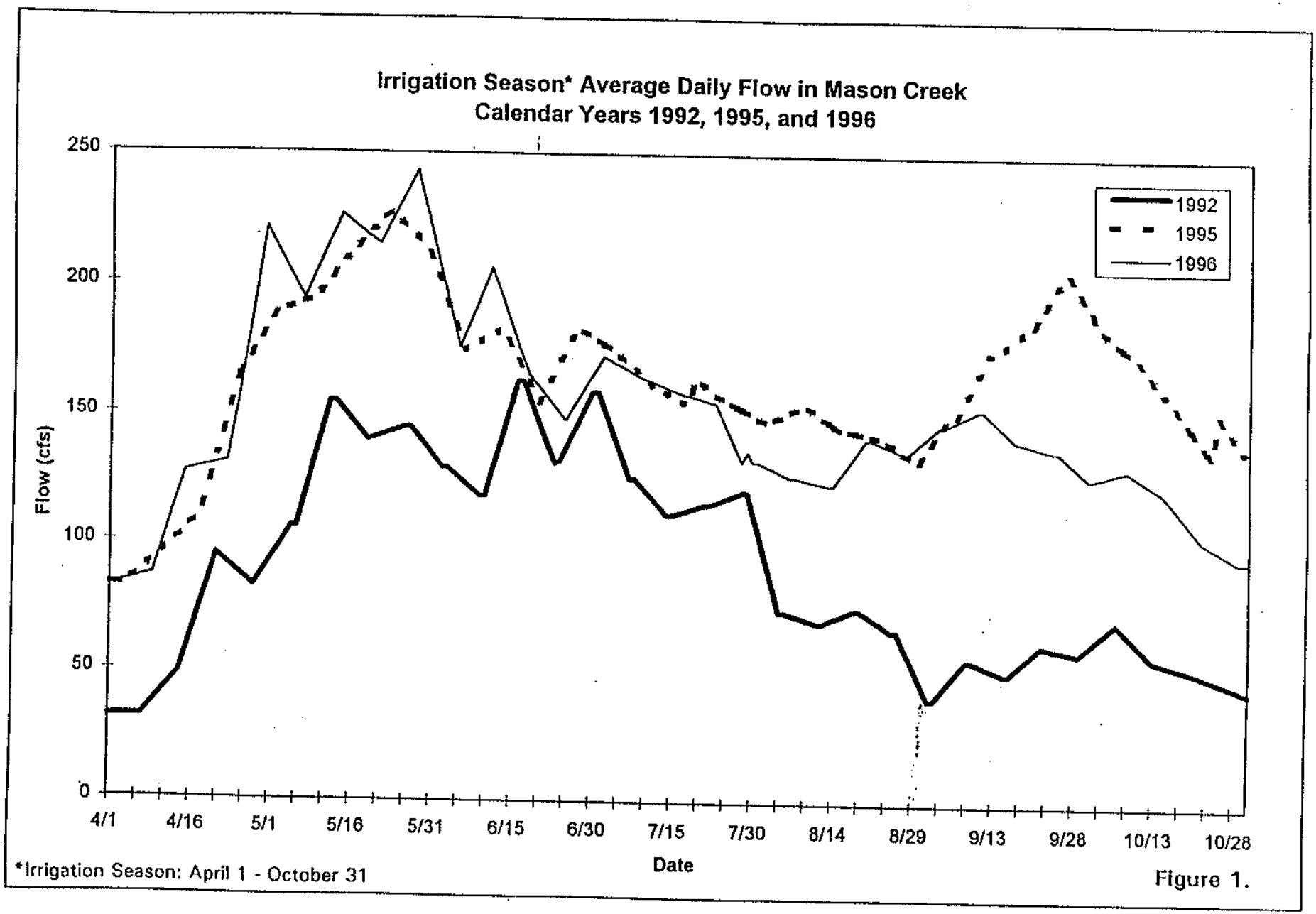


Figure 1.

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